On Her Majesty's Service

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CODE No. 27-31

ERDE opens its doors.

The Engineer

21 June 1968 (225) (5865)

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E.R.D.E. opens its doors

The Ministry of Technology's Explosive Research and Development Establishment at Waltham Abbey was set up in 1945. Not since then have the doors been opened for general inspection by the public, until last week, the occasion of the first open day. E.R.D.E.'s work has been extended to cover non-explosive materials such as polymers and adhesives, and composite materials.

WALTHAM ABBEY has had a long association with explosives. Within the boundaries of E.R.D.E. stood the gunpowder factory owned by the Walton family, which was purchased by the Government in 1787 to become the Royal Gunpowder Factory. Little is known about the very early days of the factory but it is probable that gunpowder was being manufactured on the site at the time of the Spanish Armada, 1588.

The Royal Gunpowder Factory continued in existence until the end of World War II. During the early years of the war, it was the only source of production in this country of R.D.X. (Research Department Explosive) which was the explosive of World War II.

In its early days E.R.D.E. was concerned exclusively with work on liquid and solid propellants and explosives, but over the years the establishment's activities have been extended to cover non-explosive materials such as polymers and adhesives and its research and development programme now embraces numerous projects of general industrial interest. An increasing proportion of the Establishment's work has been directed towards civil rather than military applications.

There are currently seven technical branches in E.R.D.E. Two of these are concerned with research and development on propellants, one dealing with those based on nitrocellulose while the other is responsible for work on composite propellants using plastic or rubbery binder systems. There are also now two materials branches, one of which undertakes basic and applied research on the chemistry and physics of polymers, while the other is engaged on research and development on fibre-reinforced materials and the growth of ceramic whiskers. The remaining two branches —analysis and ingredients, and chemical engineering—exist essentially to provide services for the other branches.

Fibre-reinforced materials. In the continuing search for engineering materials with improved physical properties, metals and plastics reinforced with whiskers (needle crystals) and other fibres are now the focus of attention at a number of research centres. At E.R.D.E. work on composite materials is now concentrated on the application of two types of fibre—refined asbestos for good properties at lowest cost and silicon carbide whiskers for the best properties at a reasonable cost on a mass production basis.

The effects of incorporating graded asbestos in thermoplastics are given in the table.

Asbestos, chopped carbon fibre, and whiskers, are used in the oriented reinforced thermoset composites, with epoxy or phenol formaldehyde as the base resin. Best mechanical properties are attained at the high volume packings gained by orienting the fibres, which should preferably be straight and stiff. Most pressings have been of particular chrysotile asbestos, 2 mm long and 50 μm dia.

Flexural strengths vary from 90 000 lbf/in^2 (63 276 kgf/cm^2) for chopped carbon in composite (1·65 specific gravity) to 220 000 lbf/in^2 (154 675 kgf/cm^2) for silicon carbide whiskers (1·9 specific gravity).

There are two wet processes for aligning the fibres, after cleaning and sieving into lengths. In one they are extruded in a filament of alginic acid carrier which is wound into a mat and then burned-off to remove the alginic acid. In the other they are extruded in viscous suspension direct on to a moving filter and form an aligned sheet, which can be handled. The mat or sheet is then built up to the shape required, sheets can be crossed or laid in the direction strength is required, resin is added and the article moulded in a heated press or autoclave to the finished form. Up to 1 000 lbf/in^2 (70·3 kgf/in^2) pressure is necessary to get a high enough packing density of fibre. The sheeting process is also being developed to produce rolls of tape.

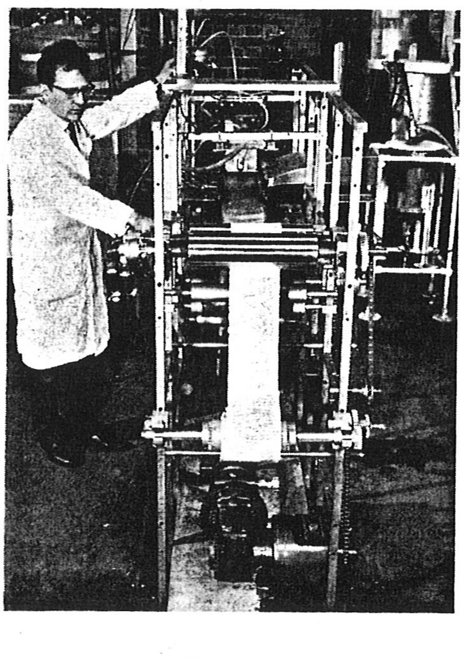
Performance of asbestos/thermoplastics

Plastic	Specific gravity	Tensile strength		Flexural modulus	
		lbf/in^2	kgf/cm^2	lbf/in^2	kgf/cm^2
Polypropylene	0·91	4 400	309	$0·15 \times 10^6$	$0·105 \times 10^6$
+40% asbestos	1·29	6 800	478	$0·77 \times 10^6$	$0·54 \times 10^6$
Toughened polystyrene	1·04	3 500	246	$0·27 \times 10^6$	$0·18 \times 10^6$
+30% asbestos	1·27	9 500	667	$1·60 \times 10^6$	$1·12 \times 10^6$
ABS	1·04	5 300	372	$0·22 \times 10^6$	$0·15 \times 10^6$
+30% asbestos	1·27	13 900	977	$1·13 \times 10^6$	$0·79 \times 10^6$
Nylon 6 ...	1·14	11 000	773	$0·34 \times 10^6$	$0·24 \times 10^6$
+30% asbestos	1·38	19 000	1 335	$1·09 \times 10^6$	$0·76 \times 10^6$

Applications can include rocket motor components such as cases, exhaust tubes and nozzles, and airframe structures, where weight but high strength, high stiffness and perhaps ablation resistance are required.

Solid propellants. Solid propellants developed at E.R.D.E. are used not only in weapons for all three Services, for space research vehicles and meteorological rockets, but also provide a convenient source of packaged power for such devices as the Martin Baker rocket ejection seat, fire-drenching equipments, engine starters and signal and line-throwing rockets. The Establishment makes use of four types of propellant—plastic, rubber-based, extruded cordite and cast double-base—to produce the wide range of characteristics needed for different applications. The current programme of applied research on propellants includes work designed to give higher or lower burning rates, greater energy content, wider temperature range of operation and reduction of smoke and flash.

Fibre alignment processes for the production of high-performance resin fibre composites



Polymer development. Much work on the development of rubber-proofed fabrics for use in flexible storage containers for liquids, hovercraft skirts and aircraft arrester tapes, has been carried out by the polymer development and applications group. The design and strength of the joints between the proofed fabric sections of Dracone flexible barges and large pillow tanks is one of the subjects under investigation. The evaluation of new plastics and rubbers is another important part of the group's work. Special-purpose moulds have been designed to produce the test specimens required for the assessment of the engineering properties of these materials and an investigation is in progress into the production of low-cost injection moulds made from metal-filled thermosetting resins. The group is also frequently called upon to look into the causes of failure of components and to suggest remedies.

Remote processing facility. To improve the performance of high-explosive and propellant systems, it is necessary to experiment with new and untried components as oxidizers, fuels and binders. In order to be able to assess explosive and ballistic properties before a detailed examination has been made of all the factors influencing sensitiveness and stability this remote processing facility has been built with the object of completely separating operators and explosive at all stages of production and test firing. A variety of operations, including dispensing, mixing, vacuum moulding, heat curing, inspection, radiography, assembly into test rounds and firing can be carried out on quantities of new compounds equivalent to 15 lb of t.n.t. while the operators are protected by a heavily reinforced concrete structure that can withstand repeated explosions. A part of the system is a remotely-controlled, 5 in (127 mm) gauge electric railway that can transfer hazardous materials between magazines, ovens, process bays and test sites.

Processing of rubbery propellants. This plant has been designed for the preparation of batches of up to 300 kg (661·4 lb) of the rubber propellants used in rocket motors. They are made by mixing powdered solids and liquids to produce a viscous slurry which can readily be cast into rocket motor casings and then cured to a rubbery solid by heating for several days at about 60°C. The key part of the plant is the specially designed stainless steel mixer incorporating an automatic drenching system actuated by an infra-red detector. To prevent contamination of the propellant by atmospheric moisture the building itself is air-conditioned and processing is carried out as far as possible under vacuum or in a dry nitrogen atmosphere.